Topic 7 – Introduction to Light

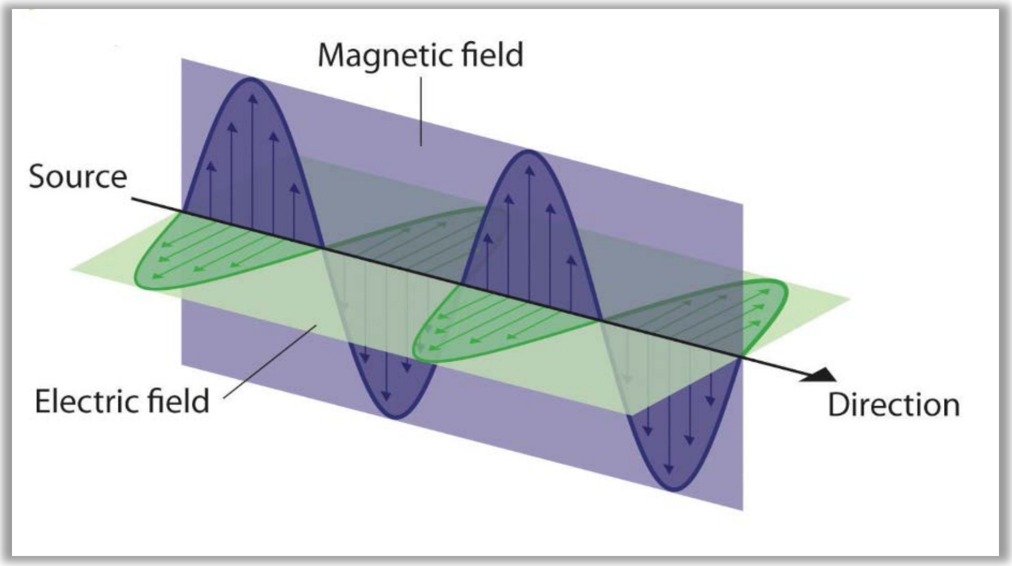
Learning Outcomes

By the end of this topic, you will know the basic terminology of light, its relationship with the human eye and how it has consequences for photography.

The three main mechanisms on a DSLR are the shutter speed, aperture and ISO. Now that we have a basic understanding of these important aspects of photography, let us look at light. By having a good understanding of light, you will be in a better position to tackle exposure when using your camera.

Light

Light, in its simplest essence, is made up of electromagnetic waves that have a specific frequency. In this frequency, a duality of properties, which consists of waves and particles, depending which way you look at them, are at play. It is the behaviour of these properties, or the behaviour of light, that impacts photography. If we consider light as a particle, there are these photons that represent the light that we see, even at this moment in time and that there are a fixed number of photons. We can count these photons to determine how intense some light actually is.



This concept is very important in photography because the more photons there are, the brighter an image will be. If we can count the photons, it introduces the idea that we can double this number to double the brightness of a particular scene. Of course, with physics, there are some other complexities at play but these are the fundamentals that apply to us as digital photographers.

The frequency of this wavelength, or how close together those troughs are in the wave, defines the colour of a specific light source, or where along this electromagnetic spectrum, that that particle or wave happens to be. You can see that we can only see a very narrow range in this spectrum of wide ranging wavelengths that light can have.

Interestingly, one of the reasons that we see this specific range of light is because it coincides with the maximum electromagnetic output from the sun. These wavelengths correspond to colour whereas the quantity of photons correspond to the intensity of that light and these are important distinctions that we need to make when talking about exposure.

We'll probably want to modify the quantity the number of photons if we need to make something a little bit darker. In that case, we could reduce the number of photons that come in. Changing colour, though, is a little trickier. These wavelengths are not something that are easily manipulated. Much of this is due to the polarisation of light, or rather which direction the waves are propagating.

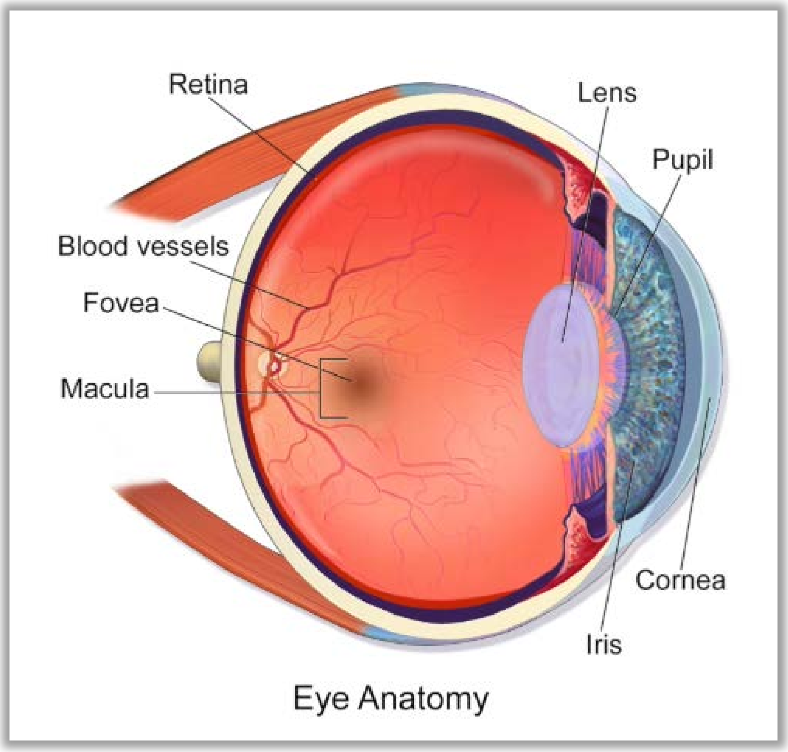
The main two concepts that we will be concerned with are:

- The quantisation of photons which refers to the intensity of this light.
- The wavelength of that light, which corresponds to the colour that we are able to see.

The Eye

The way we see is strikingly familiar with how a camera can see a scene in that we have light that comes in, its focused by a lens, and is focused then onto the back of the eye where we have cells that detect the light at a particular location.

At the centre, we have this Macula which contains a Fovea. A Fovea contains a concentration of cells that give us more detailed vison that we have in the rest of our eye.



In the centre of Fovea, there is an even more concentrated group of cells known as the Foveola. The Foveola contains two different cells that we use to sense light:

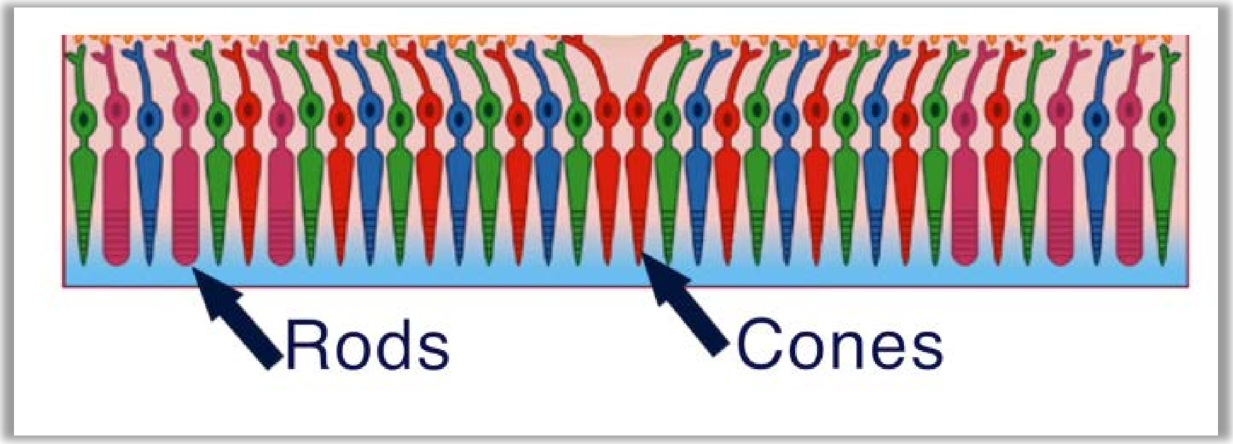
- Rods
- Cones

Each of these cells refer to different visual properties. This means that both cells sense light in different ways:

Rods are used for night vision.

Cones are used for day vision.

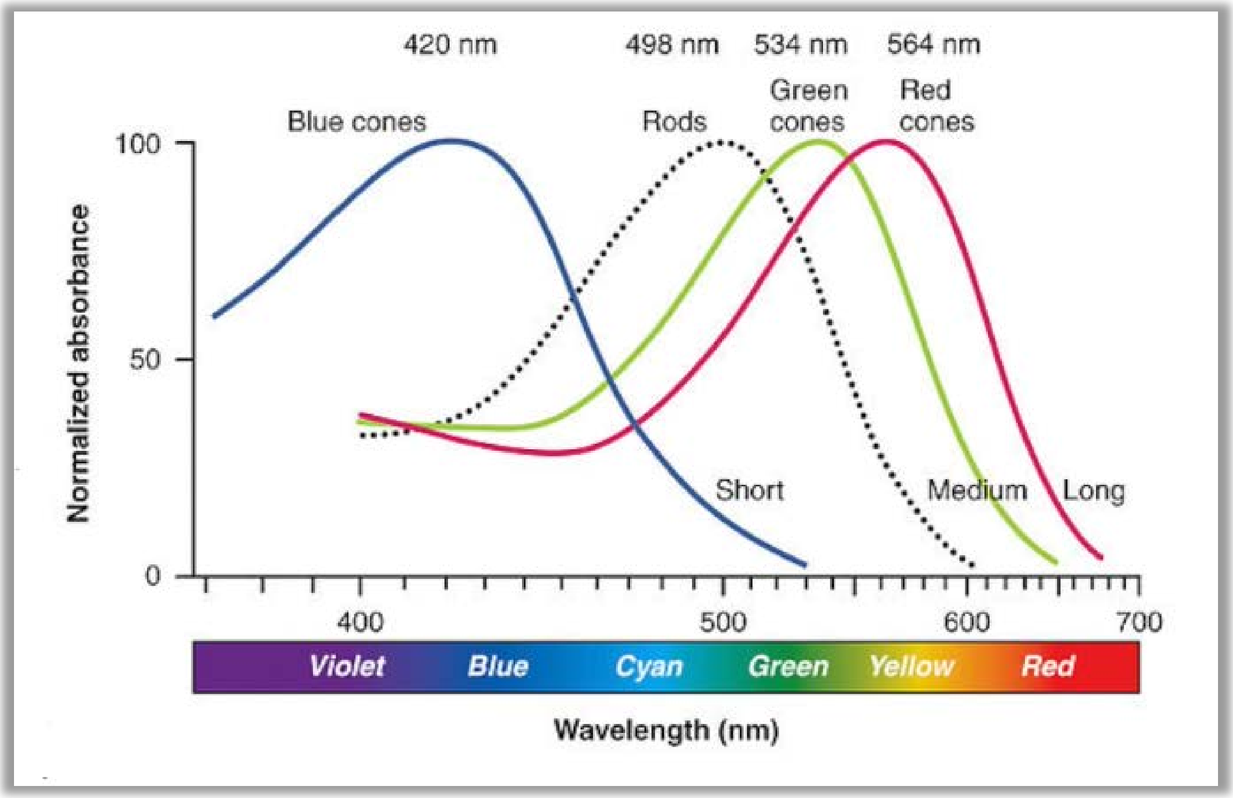
Given the fact that rods are used more for night vision, they are much more sensitive to light. They require fewer photons to be able to send a signal to the brain to inform the brain that there is some light in a certain direction.



Inside the Fovea, the concentration of cones is very high compared to the concentration of rods. This is because the centre of the eye is tailored for detail. Interestingly though, there are 22 rods for every 1 cone in our eyes. This is just because of the vast amount of area outside the centre of our vision that the rods need to occupy. We only have one type of rod cell which means that in our night vision, we only have the ability to distinguish between bright areas and dark areas. We don't really have the ability to distinguish colour as well as we would during the day.

RGB Cells

All of us will have different distributions of cones in different parts of our vision and some of us will have different colour perceptions than others. With that being said, the graph below accounts for the average person and the response of various types of cell are to various wavelengths.



There are three types of cone cells responsible for colour vision. The dashed line accounts for rod cells and you will notice that the highest portion of that response falls inside this wavelength which corresponds to the colour green. The three types of cones are: short wavelength, medium wavelength and a long wavelength. They roughly translate to blue colour for the S type, green colour for the M type and L type roughly confers red colour vision. They have wide ranges of response though and they are not bound to strict sections of wavelength.

The vast majority of cones happen to be M and L type. Considering this, we don’t have the same capability to look at blue the way we look at red and green. This means that Blue colour/ short wavelengths are more difficult for us to perceive and do not appear as bright as red and green. In genetics, M and L are on the X chromosome so red/ green colour blindness is quite prevalent in men. Interestingly though, the fact that our rod cells are not stimulated by red means that they do not react to these wavelengths.

Let us use an example; our eyes adjust the amount of light in a scene. If there is a lot of bright light, your rods diminish their sensitivity. So, a bright light in a darkened room would destroy your night vision, unless it is a red wavelength. This is why a dark room for film printing would have a red light, you can preserve your night vision without having to wait roughly 30 minutes for your eyes to adjust to a fully dark location.

<u>What have we learned today? A Summary</u>

We have learned about the eye's relationship with colour and how we see the scene.

We have also learned about the similarities between the camera and the human eye.